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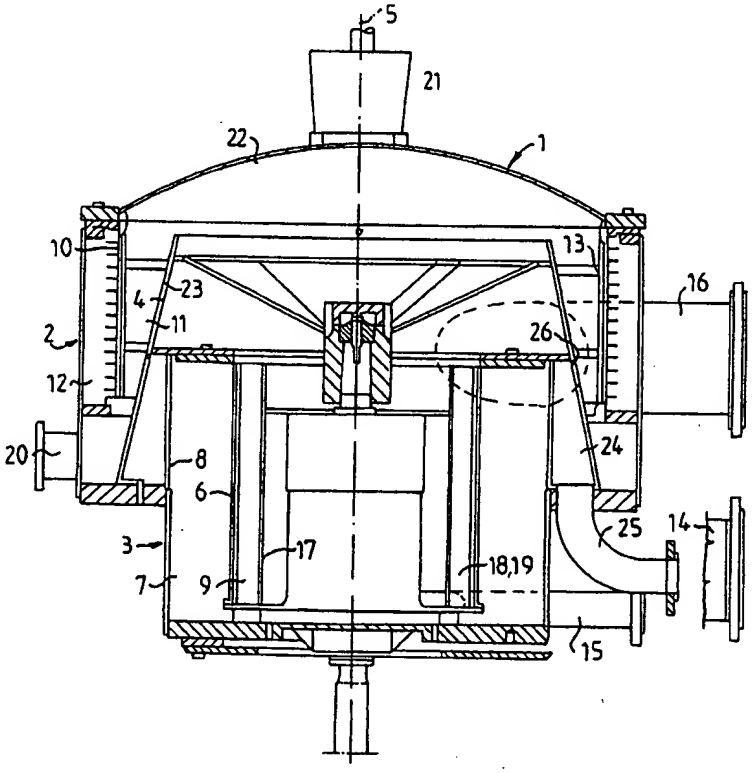
(54) Title: SCREENING APPARATUS INCLUDING TWO SCREEN MEANS

(57) Abstract

Screening apparatus for separating fiber suspensions, preferably pulp suspensions, comprising at least two co-axially arranged screen means. A first tubular screen means (6) has outside itself a first screen chamber (7) with an outer defining surface (8). A second tubular screen means (10) has inside itself a second screen chamber (11) with an inner defining surface (23). Such a screening apparatus tends to become relatively high and not to yield good screening results. According to the invention, the first screen means (6) is rotary and located on the rotor means (4). Inside the rotary screen means (6) a stator (17) with at least one pulse means (18) is provided. The smallest diameter of the outer defining surface (8) of the first screen chamber (7) is smaller than the greatest diameter of the inner defining surface (23) of the second screen chamber (11). The first screen chamber (7) is separated from the second screen chamber (11) and at least partially located inside the second screen chamber (11).



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SCREENING APPARATUS INCLUDING TWO SCREEN MEANS

This invention relates to a pressurized screening apparatus for separating fiber suspension, preferably pulp suspension. The screening apparatus comprises a screen housing with an upper chamber highest up in the screen housing, a rotor means, which is rotary about a rotor shaft, and at least two coaxially arranged screen means. A first tubular screen means divides the interior of the screen housing in radial direction into a first screen chamber located outside the first screen means with an outer defining surface, and a first accept chamber located inside the first screen means. A second tubular screen means divides the interior of the screen housing, so that a second screen chamber is formed between the second screen means and an inner defining surface. The first screen means has a smaller diameter than the second screen means and at least partially is located inside the second screen means. The screening apparatus further comprises an inlet means for fiber suspension to the screening apparatus, at least one reject outlet for reject from the screening apparatus, and at least one accept outlet means for accept from the screening apparatus.

Such a screening apparatus with several screen means (screening steps) in the same screen housing is called combi-screen. A combi-screen of the aforesaid type is used, for example, at multistep screening of pulp suspensions, preferably for fractionating or separating impurities and other foreign matter undesired in the final product, such as shives, coarse particles, scrap, stones or incompletely digested or not refined chip bits.

One example of a screening apparatus of the above described type and showing known state of art is set forth in PCT application WO95/06159. The first screen means as well as the second one are stationary. The second screen means divides the interior of the screen housing into a second screen chamber located inside the second screen means, and a second accept chamber located outside the second screen means. The pulp suspension to be screened is introduced via the inlet means to the first screen chamber, where the approved fraction, the accept, flows through the first screen means and into the first accept chamber. In the first screen chamber and near the first screen means, pulse elements, so-called wings, are provided on the rotor means, upon rotation of the

rotor means, pulses are created by the wings which assist in guiding the accept through the first screen means and into the first accept chamber. The accept flows up through the first accept chamber and further up through and inside the rotor means to the second screen chamber. In the second screen chamber, as in the first one, wings are located on the rotor in order to create pulses at the second screen means. The accept from the second screen chamber flows through the second screen means and out into the second accept chamber to be discharged via the accept outlet, which is located in the second accept chamber.

The second screen chamber communicates, and partially coincides, with the first screen chamber, so that the pulp suspension (the reject), which does not pass the second screen means, flows down to the first screen chamber. There the reject from the second screen chamber again can pass through the first screen means or flow out through the reject outlet means, which is located in the first screen chamber.

Another combi-screen is shown in PCT application WO96/02700 where a coarse screen is combined with two more screen steps. All screen means are here thought to be located above each other.

Combi-screens have been developed in order to bring about a cheaper screening apparatus than is the case if every screen step is arranged in separate screening apparatuses. Combi-screens, however, tend to be relatively high, because the screen means are combined one above the other. Combi-screens can imply compromises, which in most cases result in poorer screen results and high energy consumption.

The present invention has the object to offer a solution of the aforesaid problems and to indicate a compact combi-screen, which yields good screen results and low energy consumption. The outer defining surface of the first screen is given a greatest diameter which is smaller than the smallest diameter of the inner defining surface of the second screen chamber. The first screen chamber at least partially is located inside the second screen chamber, and the first screen chamber is separated from the second screen chamber. The inner defining surface of the second screen chamber constitutes the inner

defining surface of the second screen step. This implies that the first screen step inclusive of the screen means with the chambers outside and inside thereof are located at least partially inside the second screen step. The screening apparatus thereby can be constructed low and becomes lower the greater portion of the first screen step is located inside the second screen step.

In order to achieve a good screen result, it is important that the first screen step yields a uniform pulp quality for subsequent screen steps. In a screening apparatus of the said kind, instead of the first stationary screen means, according to known state of art, a first rotary screen means is provided. Instead of the rotating wings a stator is provided inside the rotary screen means, and on the stator at least one pulse means is located. The first screen means is placed on the rotor means to rotate with the same. Suitably at least one of the pulse means shall be a barrier/pulse element. The barrier/pulse element extends in axial direction substantially along the entire stator and the entire first screen means. Upon rotation of the first screen means the barrier/pulse element creates both suction pulses to guide the accept into the first accept chamber and pressure pulses to clean the first screen means and to prevent thickening and plugging in the first screen chamber.

The rotary screen means is given a considerably smaller diameter relative to the second screen means. Hereby the circumferential speed at screening at the rotary screen means becomes considerably lower than at the second screen means. The energy demand thereby is lower than in the case of an unnecessary high circumferential speed at the screen surface. When the circumferential speed at the screen surface is greater than demanded for the screening, for example, shives and impurities can be worked so that they are disintegrated and, thus, can pass through the screen means. The considerably smaller diameter is a great advantage when the first screen step is a coarse screen step. There one needs to have, and preferably would like to have, a considerably lower circumferential speed at the screen surface than is needed at fine screening.

The characterizing features of the invention are apparent from the attached claims.

A preferred embodiment will be described in the following, with reference to the accompanying drawings, where

Fig. 1 shows a screening apparatus according to the invention,

Fig. 2 is a cross-section of the screening apparatus in Fig. 1,

Fig. 3 shows a preferred design of the barrier/pulse elements.

The screening apparatus in Fig. 1 comprises a pressurized screen housing 1 with an upper portion 2 and a lower portion 3. In the screen housing 1 a rotor means 4 is located which is rotary about a rotor shaft 5. On the rotor means 4 and partially in the lower portion 3 of the screen housing 1 a first tubular screen means 6 is located which is rotary.

The rotary screen means 6 divides the interior of the screen housing 1 into a first screen chamber 7 outside the rotary screen means 6 and a first accept chamber 9 inside the same. The first screen chamber 7 has an outer defining surface 8 where the outer defining surface 8 partially coincides with the lower portion 3 of the screen housing 1. In order to achieve strong centrifugal forces to assist at the separation of heavy particles from the pulp suspension, the first screen chamber 7 should not be too great. The first accept chamber is defined inward by a stator 17 located inside the rotary screen means 6 and having at least one pulse means 18. The rotary screen means 6 and the stator 17 are arranged co-axially. The pulse means 18 are arranged upon rotation of the rotary screen means 6 to create suction pulses. The suction pulses assist in guiding the approved fraction, the accept, of the fiber suspension to be separated, from the first screen chamber 7 into the first accept chamber 9. The fiber suspension in this example is a pulp suspension.

The rotary screen means 6 with the first screen chamber 7, the first accept chamber 9 and stator 17 constitute a first screen step.

In the upper portion 2 of the screen housing 1 a second tubular screen means 10 is located which is stationary. The stationary screen means 10 divides the interior of the screen housing 1 in such a way, that inside the stationary screen means 10 a second screen chamber 11, and outside the stationary screen means 10 a second accept chamber 12 are formed. The second screen chamber 11 is defined inward by an inner defining surface 23, which at this embodiment coincides with the surface of the rotor means 4 in the second screen chamber 11.

In the second screen chamber 11 near the stationary screen means 10 pulse elements 13 are located on the rotor means 4. The pulse elements 13 can be one or several and are arranged upon rotation of the rotor means 4 to create pulses. The pulses assist the accepted fraction from the second screen chamber 11 to pass through the stationary screen means 10 and out into the second accept chamber 12.

The stationary screen means 10, the second screen chamber 11, the second accept chamber 12 and pulse elements 13 constitute a second screen step.

The first screen step at the embodiment shown is located lowermost of the screen steps, which at the embodiment shown are two in number.

The screen means can be of any type of screen means, with screen openings of a suitable size for passing through the desired portion of the pulp suspension. The screen means, for example, can have slits with openings between 0.1 mm and 0.5 mm, or holes with hole diameter between 0.1 mm and 12 mm.

The greatest diameter of the outer defining surface 8 of the first screen chamber 7 is smaller than the greatest diameter of the inner defining surface 23 of the second screen chamber 11. This implies that the first screen chamber 7 partially can be placed inside the second screen chamber 11. At the embodiment shown, the inner defining surface 23 of the second screen chamber 11 has conical shape, and the outer defining surface 8 of the first screen chamber 7 has cylindric shape. They can, of course, also have other shapes.

Also the first screen chamber 7, for example, can have conical shape. The shape and diameter of the outer defining surface 8 and, respectively, the inner defining surface 23 decide the size of the portion of the first screen chamber 7 which can be located inside the second screen chamber 11.

The first screen step, thus, at least partially is located inside the second screen step and, thus, the rotary screen means 6 at least partially is located inside the stationary screen means 10. The rotary screen means 6 has a considerably smaller diameter than the stationary screen means 10. Already a diameter, which is 25% smaller than the diameter of the stationary screen means 10, yields reduced energy consumption. The diameter of the rotary screen means 6, however, suitably is at least 35% and preferably up to 50% smaller than the diameter of the stationary screen means 10. In order to render it possible for the first screen step to have a capacity as high as that of subsequent screen steps, the first screen step can be made relatively high without changing the total height of the screening apparatus. This is due to the fact that only the portion of the first screen step which is located inside subsequent screen steps is made higher. In this way a functioning screen apparatus can be obtained without increasing its height too much.

An additional way of bringing about higher capacity in the first screen step is to give the rotary screen means 6 conical shape. The diameter of the rotary screen means 6 should thereby increase in the direction of the flow of the accept in the first accept chamber 9, i.e. upward at the embodiment shown. Thereby, with the same height as at a cylindric rotary screen means 6 a greater screen surface is obtained.

An inlet means 14 is provided for the supply of pulp suspension to the first screen chamber 7. The inlet means 14 suitably is located so that the pulp suspension is supplied as far upwardly as possible in the first screen chamber. This, however, is not necessary, because the first screen chamber 7 is pressurized and, thus, the pulp suspension is distributed in the first screen chamber 7 even if the pulp suspension is supplied farther down in the first screen chamber 7.

The portion of the fiber suspension in the first screen chamber 7 which cannot pass through the rotating screen means 6 is removed via a first reject outlet 15 connected to the first screen chamber 7.

The pulp suspension which has flown through the rotary screen means 6, flows as accept up through the first accept chamber 9 and out through an outlet in the upper portion. Thereafter the pulp suspension flows within the rotor means 4 and out above the same, in order then to flow down in the second screen chamber 11. The reject from the second screen chamber 11 is removed via a second reject outlet means 20, and the portion of the pulp suspension which passes the stationary screen means 10 and into the second accept chamber 12 is removed as accept from the screening apparatus via the accept outlet means 16.

Farthest upwardly in the screen housing 1 an upper chamber 22 is located. In this chamber 22 light reject is collected, i.a. the reject which is lighter than the pulp suspension in general. The light reject consists most often of plastics. In the top portion of the screen housing suitably a light reject separation means 21 is provided which, for example, can be of the type described in the Swedish patent 504 162. The light reject, thus, can be removed before the pulp suspension arrives at the second screen step.

The space 24 is a pressurized dilution chamber. Through a dilution liquid inlet means 25 dilution liquid is supplied to the dilution chamber 24. Farthest upwardly in the wall of the dilution chamber 24 adjacent the second screen chamber 11 a gap 26 is made. The dilution chamber 24 is subjected to overpressure relative to the second screen chamber 11. Thereby dilution liquid flows through the gap 26 and out in the second screen chamber 11. In the same way dilution liquid can be supplied to the first screen chamber 7.

At least one of the pulse means 18 should be a barrier/pulse element 19. At the embodiment shown, four barrier/pulse elements 19 are located on the stator 17. The barrier/pulse elements 19 can be one or several in number, but suitably 2-8 and most

suitably 3-4, and advantageously symmetrically, are located in the circumferential direction of the stator 17.

The barrier/pulse elements 19 extend in axial direction along the entire stator 17 and are tightly abutting the stator 17. They extend from the stator 17 out to and along the entire rotary screen means 6. The distance between the barrier/pulse element 19 and rotary screen means 6 shall be so short that accept substantially does not pass between these. A suitable shortest distance between the barrier/pulse element 19 and rotary screen means 6 is 4 to 10 mm. The first accept chamber 9 thereby is divided into a number of small accept cells 9_1, 9_2, 9_3 and 9_4.

At the embodiment shown, the barrier/pulse elements 19 extend in axial direction straight down from above. In order to assist in feeding the accept in the accept cells 9_1, 9_2, 9_3, 9_4 and out of the first accept chamber 9, the barrier/pulse elements 19 can, instead, be designed so that they, seen axially in the direction to the accept outlet from the first accept chamber 9 (at this embodiment upward from below), deflect in the rotation direction of the rotary screen means 6. This implies that the accept more easily can be moved out of the first accept chamber 9, and thereby a lower pressure drop above the stator 17 is obtained.

Upon rotation of the rotary screen means 6, a suction pulse is created on the rear side of the barrier/pulse element 19, seen in the rotation direction. The approved fraction, the accept, of the pulp suspension flows thereby through the rotary screen means 6 and into one of the accept cells 9_1, 9_2, 9_3 or 9_4. The main portion of the accept flows thereafter up through the first accept chamber 9 and through the screening apparatus.

During the rotation of the rotary screen means 6 the accept in the accept cells 9_1, 9_2, 9_3 and 9_4 partially follows along in the rotation of the rotary screen means 6. When the accept thereby approaches the barrier/pulse element 19, portions of the accept are pressed back through the rotary screen means 6 and out into the first screen chamber 7. Thereby the rotary screen means 6 is cleaned of possible cloggings, and the pulp suspension in the first screen chamber 7 is mixed with the accept fraction from the first

accept chamber 9. This prevents too much thickening of the pulp suspension in the first screen chamber 7. At the same time also co-rotation of the accept in the first accept chamber 9 is prevented. The risk of plugging in the first screen chamber 9 is reduced, and at the same time a reduced energy consumption is obtained.

In order to cause the barrier/pulse element 19 upon rotation of the rotating screen means 6 to create strong pressure pulses to the pulp suspension in the first screen chamber 7, a suitable design of the barrier/pulse element 19 is the one shown in Fig. 3. Facing toward the rotary screen means 6, the barrier/pulse element 19 has a pulse surface 27 where the distance between the pulse surface 27 and rotary screen means 6 decreases in the rotation direction of the rotary screen means 6 to the point where the barrier/pulse element 19 is closest to the rotary screen means 6. When the accept approaches the barrier/pulse element 19, it is forced by the shape of the barrier/pulse element 19 out through the rotary screen means 6 and out into the first screen chamber 7.

The barrier/pulse element 19, instead of being attached to the stator 17, can be formed as one unit with the same.

The barrier/pulse element 19, of course, can have another shape than the one shown. Different designs of the pulse surface 27 yield pulses of different strength.

The portion of the barrier/pulse element 19 which is faced against the rotation direction of the rotary screen means 6 should be designed so that it assists in guiding the accept out to the rotary screen means 6. This surface, thus, seen from the inside of the stator 17 and out to the rotary screen means 6, should be radial or deflect in the rotation direction of the rotary screen means 6.

A variant of the stator is that it is provided, in addition to barrier/pulse elements, also with pulse elements of conventional type. It can, for example, be provided with 4 barrier/pulse elements and between them with usual pulse elements, where the accept can pass between the wing and stator.

At the embodiment shown, the stator 17, the rotary screen means 6 and the outer defining surface 8 of the first screen chamber 7 all have the shape of a cylinder. One or several of the stator, the rotary screen means and, respectively, the outer defining surface of the first screen chamber can also, for example, be conical with different or equal angle relations in relation to each other. By forming the outer defining surface of the first screen chamber and, respectively, the stator cylindric or conical, the accessible space between them can be changed. By changing, for example, the rotary screen means from cylindric to conical, the relation between accessible space in the first screen chamber and, respectively, the first accept chamber can be changed. When thereby the accessible space in axial direction becomes different, the space in the first accept chamber should increase in the direction to the accept outlet from the same, and the space in the first screen chamber should be greatest at the inlet, This applies, of course, also to the subsequent screen steps.

Accept outlet means, reject outlet means and inlet means, of course, can be arranged in places in the screening apparatus other than those indicated at the embodiment shown. The number of accept outlet means and reject outlet means and their location depends on the design of the screen apparatus and on the number of screen steps comprised therein.

The second screen step referred to in the description is supposed to be the step which at least partially is located outside the first screen step.

A screening apparatus of the kind stated above, of course, can comprise more than two screen steps arranged with different ways for the pulp suspension to flow within and between the different screen steps. The first screen step can be located uppermost of the screen steps and be followed after by one or more screen steps. When the first screen step is arranged uppermost of the screen steps, it suitably is placed so that the accept leaves the first screen step in the lower portion thereof.

A screening apparatus according to the invention can also, for example, be designed so that from the first screen step the accept flows up to the upper screen step and then

down to the second screen step, which partially is located outside the first screen step. Hereby combi-screens with three steps are obtained.

The invention, of course, is not restricted to the embodiment shown, but can be varied within the scope of the claims with reference to the description and Figures.

Claims

1. A screening apparatus for separating fiber suspensions, preferably pulp suspensions, comprising a pressurized screen housing (1), an upper chamber (22) farthest upwardly in the screen housing (1), a rotor means (4) which is rotary about a rotor shaft (5), at least two co-axially arranged screen means, where a first tubular screen means (6) in radial direction divides the interior of the screen housing (1) into a first screen chamber (7), located outside the first screen means (6), with an outer defining surface (8), and a first accept chamber (9) located inside the first screen means (6), and where a second tubular screen means (10) divides the interior of the screen housing (1), so that a second screen chamber (11) is formed between the second screen means (10) and an inner defining surface (23), where the first screen means (6) has a smaller diameter than the second screen means (10) and at least partially is located inside the second screen means (10), and where the screening apparatus further comprises an inlet means (14) for fiber suspension to the screening apparatus, at least one reject outlet means (15,20) for reject from the screening apparatus, and at least one accept outlet means (16) for accept from the screening apparatus, characterized in that the first screen means (6) is rotary and located on the rotor means (4), that inside the first screen means (6) a stator (17) is located with at least one pulse means (18), that the smallest diameter of the outer defining surface (8) of the first screen chamber (7) is smaller than the greatest diameter of the inner defining surface (23) of the second screen chamber (11), and that the first screen chamber (7) is separated from the second screen chamber (11) and at least partially located inside the second screen chamber (11).

2. Apparatus as defned in claim 1, characterized in that the first screen means (6), seen axially, is located lowermost of the screen means.

3. Apparatus as defined in claim 2, characterized in that the first accept chamber (9) is designed so that accept flows upward through the first accept chamber (9) and leaves the same in the upper portion thereof.

4. Apparatus as defined in any one of the preceding claims, characterized in that at least one of the pulse means (18) is a barrier/pulse element (19), which in axial direction extends along the entire stator (17) and substantially the entire first screen means (6), and is tightly fitting to the stator (17) and extends from the stator (17) out to the first screen means (6), so that accept substantially is prevented from tangentially passing the barrier/pulse element (19).

5. Apparatus as defined in claim 4, characterized in that the barrier/pulse element (19) facing toward the first screen means (6) has a pulse surface (27) where the distance between the pulse surface (27) and first screen means (6) decreases in the rotation direction of the first screen means (6).

6. Apparatus as defined in any one of the preceding claims, characterized in that the stator (17), the first screen means (6) and the outer defining surface (8) of the first screen chamber (17) all are cylindric.

7. Apparatus as defined in any one of the claims 1 to 5, characterized in that the first screen means (6) is conical.

8. Apparatus as defined in any one of the claims 3 to 7, characterized in that a light reject separation means (21) is located in the top portion of the screen housing (1) for separating light reject from the upper chamber (22) of the screen housing (1).

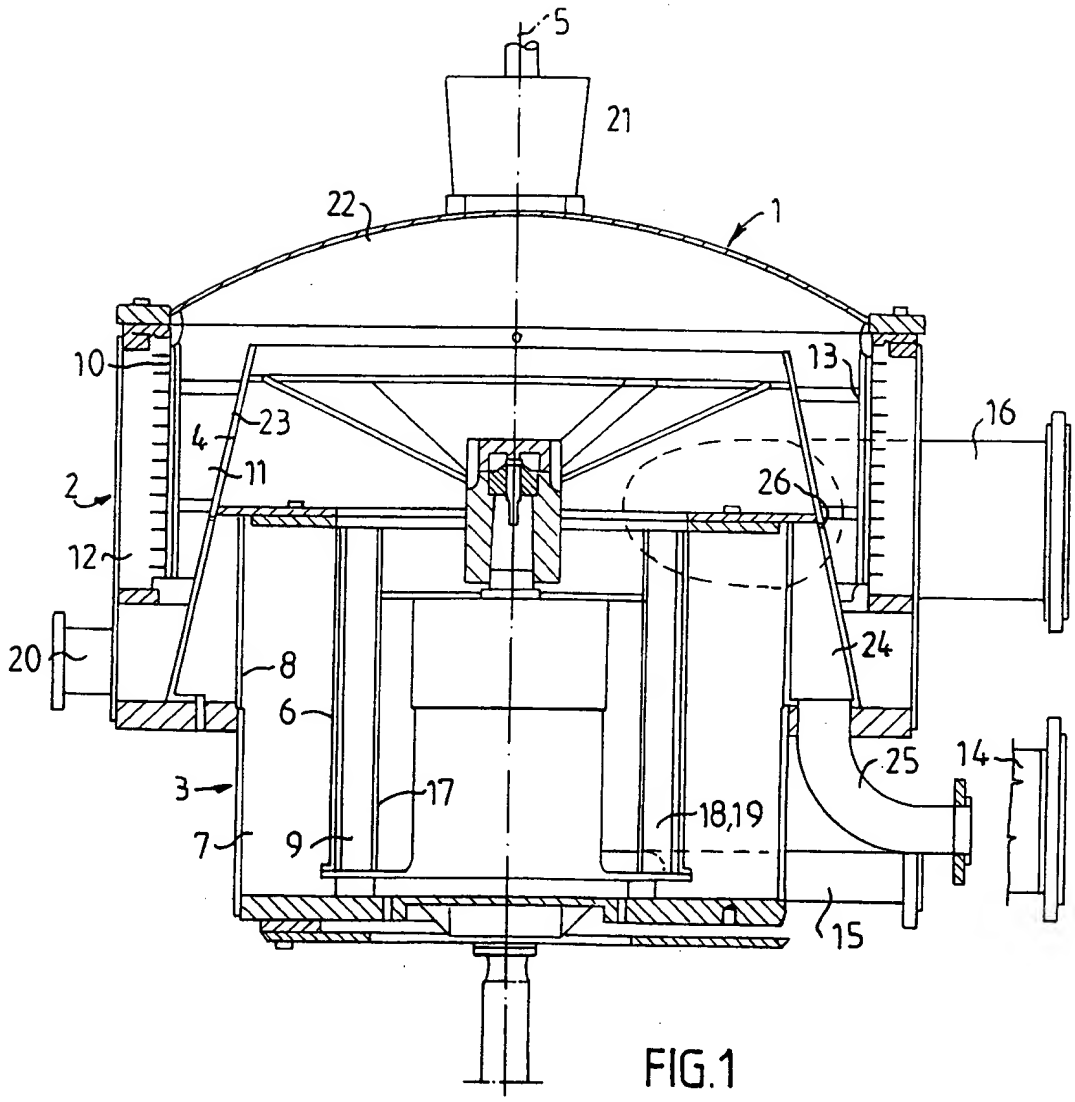

FIG.1

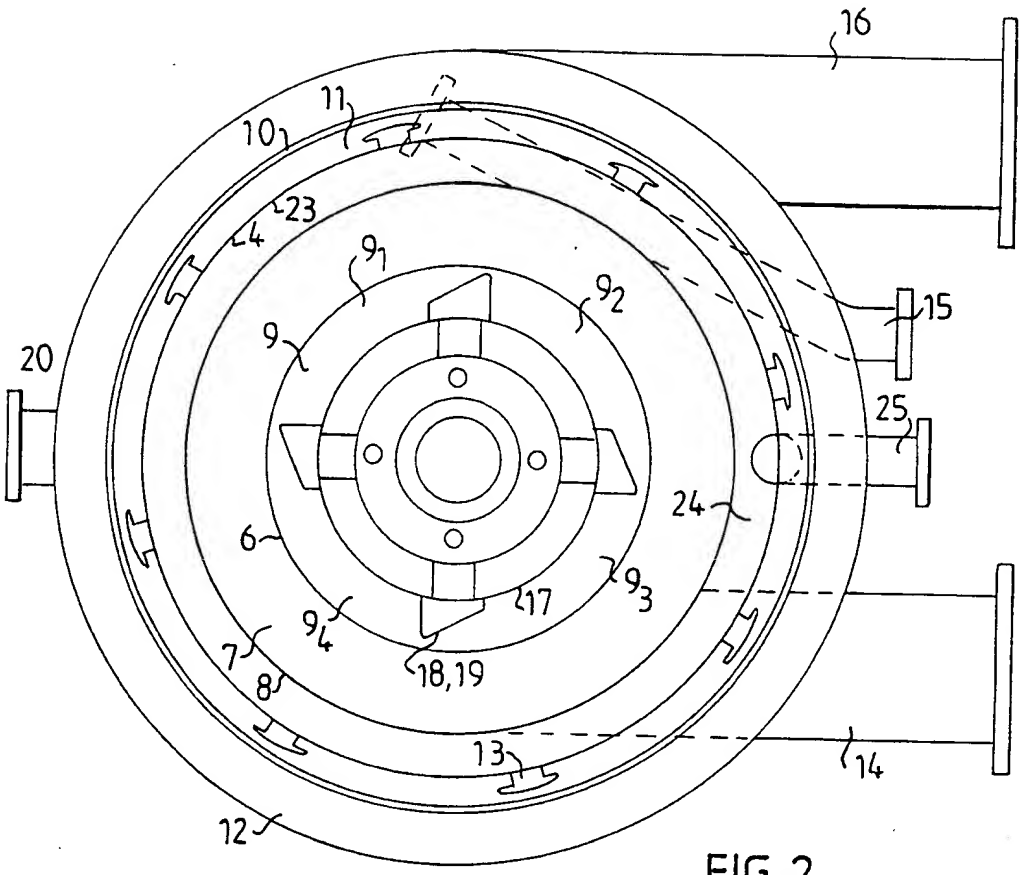
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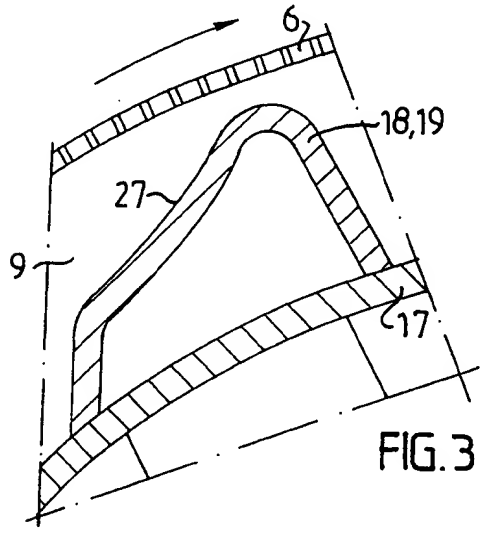
FIG. 2


6
18,19
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17

FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 00/00421

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: D21D 5/02, D21D 5/06
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: D21D, B07B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 9506159 A1 (VALMET-TAMPELLA OY), 2 March 1995 (02.03.95), page 5, line 4 - line 12; page 6, line 19 - line 31; page 11, line 22 - page 12, line 6, figures 1,6	1-8
A	SE 308445 B (N G H NILSSON), 10 February 1969 (10.02.69), figure	1-8
A	US 3785495 A (EMIL HOLZ), 15 January 1974 (15.01.74)	1-8
A	US 3939065 A (STEN ESKIL EINARSSON AHLFORS), 17 February 1976 (17.02.76)	1-8

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Date of the actual completion of the international search	Date of mailing of the international search report
10 July 2000	21 -07- 2000
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Information on patent family members

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